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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Land surface albedo and vegetation feedbacks enhanced the Millennium drought in south-east Australia" *by* J. P. Evans et al.

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The manuscript by Evans et al. addresses the impact of dynamics in vegetation and albedo during the Millennium drought in Australia on simulated climate and precipitation. This is a highly relevant topic, since there are still considerable uncertainties in the contribution of land surface-atmosphere coupling to drought amplification at (sub-)continental scales. The study consists of a relatively straightforward model experiment, and is generally well presented. I have one general comment related to the apparent absence of any process understanding or a priori hypothesis on the role of vegetation and albedo, and some smaller comments that will need to be addressed before possible publication.

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Discussion paper

1 Main comment

My main comment concerns the lack of process understanding. First, no hypothesis is formulated on how and why albedo and vegetation are expected to impact atmospheric conditions. Such a discussion on the role of albedo and vegetation in land surface-atmosphere exchange in semi-arid regions should be added. Secondly, the authors refer to “changes in albedo lead to...” etc., without specifying the direction of the change. This makes it complex for the reader to follow the argumentation, because several cross-checks between the Introduction and Figures and needed to know whether this is consistent with previous studies. This should be improved. Also, the authors did not look into any additional information that can be output by the model, such as soil moisture, temperature or information of the surface energy balance partitioning. An additional figure with analysis of some of these variables could strengthen the story considerably.

2 Smaller comments

Albedo anomalies in Figure are plotted with respect to a long-term mean (i.e. not a mean seasonal cycle). I would prefer to see the anomalies with respect to their mean seasonal cycle, so that longer scale deviations are more easily recognized.

A description of the selected land surface parameterization in WRF is lacking. As a result, it is unclear how vegetation fraction affects land surface processes. What is the parameterization/equation(s) were vegetation fraction is used? And how does it affect the evolution of soil moisture?

The authors compare default vegetation and albedo fields from AVHRR with MODIS estimates. These fields differ not only in their inter- and intra-annual variability, but likely also in their mean (at least judging from Figure 3 it seems that most observed

fields have a bias). How much of the precipitation signal can be attributed to the bias rather than interannual variability in vegetation and albedo?

Another comment related to the magnitude of the precipitation signal is whether or not the changes in precipitation are significant when compared to making other more subjective changes in the model, such as choosing different physics packages. In a recent study on heatwave conditions in Europe, Stegehuis et al. (2015) for instance found that the choice for different physics packages significantly affected temperatures and precipitation. This should be discussed.

Concerning the references, a key study on effects of land surface-atmosphere feedbacks on multi-year droughts that seems to be missing is a study by Schubert et al. (2004) on the U.S. Dust Bowl.

3 References

Schubert, S. D. et al. (2004). On the cause of the 1930s Dust Bowl. *Science* **303**, 1855–1859.

Stegehuis, A. I. et al. (2015), An observation-constrained multi-physics WRF ensemble for simulating European mega heat waves. *Geosci. Model Dev.*, **8**, 2285–2298.

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